

HEATING/AIR-CONDITIONING INSTALLATION FOR A MOTOR
VEHICLE.

Field of the invention

The subject of the present invention is a heating/air-conditioning installation for a motor vehicle, comprising, on the one hand, a thermal loop which includes a refrigerating compressor, a condenser, a pressure-reducing valve and an evaporator and, on the other hand, a heating element.

Background of the invention

In known installations, it is known to use an air/refrigerant-fluid exchanger within a heating and air-conditioning apparatus to heat the passenger compartment via the condensation of hot gases leaving a compressor, for example by employing a heat pump. This implies the use of an external exchanger in order for the air conditioning to operate. This is because the disposal of the heat energy into the surroundings always takes place by the use of an air/refrigerant-fluid exchanger which is located outside the passenger compartment, or by passing through an intermediate fluid such as water. In this latter case, a first loop makes it possible to take up the heat energy in a water/refrigerant-fluid exchanger, and subsequently a second loop allows this same heat energy to be disposed of into the surroundings by means of an air/water exchanger.

It is also known to use a water/refrigerant-fluid exchanger as a condenser as described in the French Patent Application No. FR 2 761 405 filed on 27 March 1997 by the Applicant. This embodiment, which gives flexibility of location of this exchanger, needs overcooled water to be available, having a temperature close to 55°C, in order to be able to condense the

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refrigerant fluid correctly at acceptable levels of pressure and of energy consumption. In these embodiments, the exchanger is placed outside the passenger compartment and, obviously, outside the air-conditioning apparatus.

Moreover, all the solutions described above exhibit the drawback of making use of a heating element (heating radiator) which operates only in cold weather or in order to de-humidify, and a condenser which operates only in hot weather or in order to de-humidify.

The basic idea of the present invention is to group together the heating element and the condenser into a single element which will operate in both modes.

Summary of the invention

According to the present invention there is provided a heating/air-conditioning installation for a motor vehicle, comprising, on the one hand, a thermal loop in which a refrigerant fluid flows and which includes a refrigerating compressor, a gas cooler, especially a condenser, a pressure-reducing valve and an evaporator, and, on the other hand, a heating element, wherein the gas cooler and the heating element are grouped together into a single exchanger including a main module forming a main air/heat-carrying fluid/refrigerant-fluid exchanger.

The heat-carrying fluid may be hot water, for example the cooling water from the engine, or else be overcooled water or even demineralised water of a fuel-cell loop.

The invention particularly makes it possible to bring together, in geographical terms, the gas cooler, especially a condenser, and the evaporator, which is beneficial in terms of the cost of pipework. Moreover, the invention makes it possible to reduce the number of

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connections through the bulkhead or to group together all these connections which are sources of possible leaks of refrigerant fluid.

The said main exchanger advantageously exhibits:

- at least one surface for exchanging between the air and the heat-carrying fluid flowing through the main exchanger and/or at least one surface for exchanging between the air and the refrigerant fluid flowing through the main exchanger, and

- at least one surface for exchanging between the heat-carrying fluid and the refrigerant fluid of the thermal loop flowing through the main exchanger.

The main exchanger may consist of a stack of modules, each of which includes:

- an element for exchanging between the heat-carrying fluid and the refrigerant fluid of the thermal loop, having at least one surface in thermal contact with an element for exchanging with the air; and

- the said element for exchanging with the air.

According to a first preferred variant, the said element for exchanging between the heat-carrying fluid and the refrigerant fluid successively exhibits:

- a first heat-carrying fluid circulation element;

- a refrigerant-fluid circulation element having a first surface in thermal contact with a first surface of the first heat-carrying fluid circulation element, and a second surface in contact with a first surface of a second heat-carrying fluid circulation element, and

- the said second heat-carrying fluid circulation element,

and in which the said element for exchanging with the air exhibits a first surface for exchanging with a second surface of the second heat-carrying fluid circulation element and a second surface for exchanging

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with a second surface of the first heat-carrying fluid circulation element of an adjacent module.

The said element for exchanging between the heat-carrying fluid and the refrigerant fluid may successively exhibit: a third heat-carrying fluid circulation element having a first surface in thermal contact with a second refrigerant-fluid circulation element of the thermal loop; and the said second refrigerant-fluid circulation element. In that way, the main exchanger exhibits surfaces for exchanging between the air and the heat-carrying fluid, between the air and the refrigerant fluid and between the heat-carrying fluid and the refrigerant fluid.

The said main exchanger may include a collector of the heat-carrying fluid and a collector of refrigerant fluid of the thermal loop which are arranged at opposite ends of the exchanger.

The element for exchanging between the heat-carrying fluid and the refrigerant fluid of the thermal loop may exhibit at least one heat-carrying fluid circuit element for making the heat-carrying fluid circulate along an outwards and return path from and to the heat-carrying fluid collector and at least one refrigerant-fluid circuit element for making the refrigerant fluid of the thermal loop circulate, preferably at least partly counter to the flow of the heat-carrying fluid, along an outwards and return path from and to the refrigerant-fluid collector.

The refrigerant-fluid collector may also exhibit an element of volume forming a refrigerant-fluid bottle for the thermal loop. This bottle may be of extruded metal and it may, in particular, be co-extruded with the refrigerant-fluid collector.

According to a preferred variant, the said exchanger includes an auxiliary module forming an auxiliary exchanger of the heat-carrying

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fluid/refrigerant fluid which is traversed by the refrigerant fluid of the main loop and by the heat-carrying fluid, for example the engine cooling water, and which is intended to serve as a sub-cooling exchanger for the refrigerant fluid of the main loop and/or as evaporator for a heat pump.

The said auxiliary module may include a stack of heat-carrying fluid/refrigerant fluid exchange modules.

The thermal loop may exhibit a first routing circuit in order, in heating mode, to form a heat pump the condenser of which is the said main exchanger and the evaporator of which is the said auxiliary exchanger.

According to another variant, the thermal loop exhibits an additional evaporator for operation in heating mode, and a second routing circuit in order, in heating mode, to form a heat pump the condenser of which is the said main exchanger and the evaporator of which is an additional evaporator.

The thermal loop may exhibit a third routing circuit in order, in a thermal heating mode, to form a heating loop and including the said compressor and the main exchanger and the auxiliary exchanger as appropriate, the refrigerant-fluid outlet of the main exchanger being coupled to the inlet of the compressor, either directly or via a pressure-reducing valve. This pressure-reducing valve can be arranged downstream of the main exchanger, which enhances the thermal exchanges, since the refrigerant fluid in the gaseous state is hotter.

The heating loop may exhibit a pressure-reducing valve arranged before or after the main exchanger, which makes it possible to work with a lower-density fluid, which enhances the efficiency, and at lower speed, and thus with lower noise. In the mode of heating via the refrigerant fluid, the circulation of

heat-carrying fluid (especially of water) can be allowed or prevented on the basis of the temperature discrepancies between the two fluids and of the overall throughput of the system.

The thermal loop may include a supply device for supplying the main exchanger, either with cooling water, for example from the motor of a fuel cell or from a battery system, or with overcooled water.

The installation may then exhibit:

- an air-conditioning mode in which the main exchanger is traversed by refrigerant fluid and by overcooled water

- a heating mode in which the main exchanger is traversed by the cooling water from the vehicle engine.

The installation may exhibit a mixing flap which, in the air-conditioning mode, is in a closed position in which the main exchanger is isolated from the airflow.

The installation may then equally exhibit a de-misting mode in which the air-conditioning mode is activated, and in which the mixing flap is in an at least partially open position, so that the main exchanger is traversed by at least a part of the airflow.

The installation may exhibit a preassembled module including the said exchanger, the said evaporator, at least one air duct, as well as air mixing and/or distribution means.

The preassembled module may include the said refrigerating compressor and/or the pressure-reducing valve, and/or an electric pump and/or a bottle of refrigerant fluid.

The preassembled module may equally include a structural element of the vehicle and/or a steering column and/or an inflatable bag and/or a pedal assembly and/or a motor of the drive members for the windscreen

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possible to arrange the compressor close to the bulkhead 50 in the engine compartment, or even in the passenger compartment itself.

It is thus possible to produce a very compact loop in which the lengths of the pipework are very short and which is physically very close to the heating and air-conditioning apparatus proper which includes all the air ducts, flaps, etc. It then becomes possible to produce the entire loop in a single module which can form part of a "cockpit" module integrating at least the heating and air-conditioning apparatus. This module may particularly integrate heat exchangers, air ducts and mixing and distribution means which form part of a conventional air-conditioning apparatus, as well as housings suitable for accommodating a refrigerating compressor and/or an electric pump and/or a bottle of refrigerant fluid and/or a pressure-reducing valve and/or a structural element and/or a steering column and/or several inflatable bags and/or a pedal assembly. This module may constitute a subassembly which is preassembled outside the main motor-vehicle assembly line and which is mounted directly as a whole. In that way, this loop can be made completely hermetic, particularly by virtue of its welded joints. This makes it possible to produce a system exhibiting no leaks of refrigerant.

This subassembly can also include the motor and/or the members for driving the windscreen wipers, as well as the water separator for the air intake into the passenger compartment and/or at least one housing able to accommodate an air-cleaner filter.

The module may also include the power electronics which manage the compressor and/or the electric pump and/or an alternator/starter. These electronic components can be grouped together into a

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as represented in Figure 5, of a water/refrigerant-fluid exchanger 55 which serves as an evaporator in heating mode of the heat pump and which is traversed by cooling water, for example the cooling water from the engine ERM, which makes it possible to increase the quantity of heat available in the passenger compartment by drawing heat energy from the engine-cooling water.

As will be seen in the rest of the description, this exchanger can be integrated into the exchanger 42.

In air-conditioning mode, the three-way valve 53 directs the refrigerant fluid leaving the condenser 42 towards the bottle 43 of the pressure-reducing valve 44, the evaporator 45 and the return to the compressor 41. In heating mode, the three-way valve 53 directs the refrigerant fluid leaving the exchanger 42 to the tapping 52 and thus in the case of Figure 5 through the additional evaporator 55.

The operation of the circuit of Figure 4 is very simple. The compressor 41 supplies the exchanger 42 and the fluid at the outlet from it is re-injected into the inlet of the compressor 41. This is a case of thermal heating in which the energy supplied by the exchanger 42 is equal (to within the losses) to the mechanical work by the compressor 41.

As Figure 6a shows, the exchanger 9 has a main exchanger 7, consisting of a stack of elements 5 or 5' for exchanging between the water and the refrigerant fluid, and of elements 4 for exchanging with the air. This main exchanger can be used as an exchanger 42 in the examples described. It preferably includes an additional exchanger 8 which consists of a stack of elements 5 and 5', for example, without elements 4 being interposed. This auxiliary exchanger 8 can be used in particular as an evaporator 55 for heating by heat pump as represented in Figure 5. It can also be used as an exchanger for sub-cooling of the refrigerant

fluid of the main loop. This makes it possible to obtain a refrigerant fluid said to be overcooled to a temperature lower by about 5°C to 10°C than its condensation temperature. This makes it possible to optimise the performance of the condenser placed downstream of the additional exchanger 8. The refrigerant-fluid collector 72 exhibits a tubular part provided with a separation 76 so as to separate the fluid which arrives, for example, via a lower inlet duct 74 and leaves again via an outlet duct 73 (Figures 6b and 6c). Moreover, and as represented in Figures 6c and 6d, the refrigerant-fluid collector 72 is preferably equipped with a cylindrical reservoir 77 which forms a bottle for refrigerant fluid. This bottle is advantageously made of extruded metal, this extrusion possibly being carried out at the same time as that of the collector, or else the extruded bottle is fixed onto the collector by brazing. It will be noted that, by reason of the compactness of the installation due to the shortening of the links between components, as well as to the better leaktightness, or even the total leaktightness which is obtained, the volume of this bottle can be considerably reduced by comparison with the one that is necessary in a conventional installation.

Figure 7a shows a routing valve 79 which is a three-way valve which makes it possible to route the intake of the refrigerant fluid toward the main exchanger 7 and/or the auxiliary exchanger 8.

Figure 7b shows in more detail an embodiment of the refrigerant-fluid collector 72, to which is fastened the bottle 77 in the case in which the refrigerant fluid exits via the bottle 77. The refrigerant fluid enters at 92 through the top of the collector 72, and runs through the main exchanger 7, and it then enters the bottle 77 via an aperture 93

